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Original Communication

The CT characteristics of orbital blowout fracture and its medicolegal expertise

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Abstract

To explore the CT characteristics of orbital blowout fracture, we reviewed 76 cases with orbital blowout fracture and analyzed their clinical forensic characteristics. The missed diagnosis rate of cranial CT was 26.3%, and plain X-ray was 47.4%. The orbital CT examination has advantages in diagnosing orbital blowout fracture. In 42 cases fractures were simple medial orbital wall fracture, 30 cases were inferior orbital fractures. Loss of clinical signs included local haematoma, bone continuity, and displacement of bone fragments were mostly seen in CT image. Clinical signs and symptoms included local haematoma, whilst diplopia as the most common clinical symptom. Visual acuity was rarely affected after fracture. It is concluded that orbital blowout fracture may be misdiagnosed if only cranial CT and plain X-ray are used. Diagnose the orbital blowout fracture only by craniocerebral CT and head X-ray. Orbital CT should be done if the clinical signs are suggestive of orbital blowout fracture Visual acuity was affected and diplopia may be present.

Keywords: Orbital blowout fracture; CT; Diplopia; Clinical forensic medicine

1. Introduction

Orbital blowout fracture refers to the fracture of orbital wall without damage to orbital margin resulting from external force on the eye.[1] The rate of missed diagnosis of this kind of fracture is high. In Liu Jun's study 42.6% of fractures were missed.[2] This study reviews retrospectivley 76 case of orbital fracture emphasising the problems of diagnosis and medicolegal appraisal.

2. Methods

The materials of orbital blowout fracture are based on forensic appraisal cases of living body from this department, the Beilin branch and the Chang'an branch of public security bureau of Xi'an city from 1992 to 2004. The total cases amount to 76. All the materials of medical history and identification data were classified and counted according to age, sex, the object that caused injury and the type of trauma. Moreover, they were further analyzed and arranged in order.

3. Results

1. *General status*: Male:n = 63, female:n = 13; ages range from 18 to 62y, mean–35y; occupation: agricultural worker [???]: 28, worker: 23, student: 12, other: 13 cases. Injuries were sustained to the left eye – $n = 52$ and the right – $n = 24$.
2. *Cause of injury*: Injury by fist and foot: 59 cases, by brick and stone: 10 cases, by cudgel: 7 cases.
3. *Image examination*: A total of 76 cases all received CT examination on the head and eye. Of 57 cases, which had immediate head CT after the injury, 42 cases were

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reported to suffer from the fracture of orbital wall; of 19 cases, which had plain skull X-ray examination after the injury, 10 cases were reported to have the fracture of orbital wall; of 19 cases, which first had X-ray examination and then received orbital CT examination, 19 cases were reported to get the fracture of orbital wall.

4. *Sites of fracture*: There were 42 cases (55.2%), which had medial orbital wall fracture, 30 cases (39.5%), which had inferior orbital inferior wall fracture, 3 cases (4.0%), which had lateral wall fracture, and 1 case (1.3%), which had orbital superior wall fracture.
5. *Clinical manifestation*: Discoloration around the eye, decreased visual acuity and diplopia are the main clinical symptoms (see Table 1).
6. *Visual acuity changes*: Table 2 shows the eyesight condition of injured eyes after orbital blowout fracture.
7. *CT characteristics*: The direct CT image mostly displayed the breaking off of bone substance continuity of orbital wall, displacement of bone fragments and abnormal curvature of orbital wall. Additionally the indirect signs included haematoma at the site of fracture, ocular muscle thickening and intraorbital (see Figs. 1 and 2). The details are seen in Table 3.
8. *Results of medicolegal investigation*: The results of clinical medicolegal investigation for all 76 cases of orbital blowout fracture are shown in Table 4, according to the Human Slight Injury Identification Standard (PR China) and Human Severe Injury Identification Standard (PR China).

4. Discussion

1. The orbit contains or is bounded by the orbital superior wall, orbital medial wall, orbital lateral wall, orbital inferior wall, optic canal, optic foramen and orbital margin. The orbital margin is composed of frontal bone, zygomatic bone and maxillary bone, and is more solid than orbital wall. Therefore, when the globe sustains external force, fracture of orbital wall will frequently occur, but the orbital margin remains intact. The orbital superior wall is made up of the frontal bone and the lesser wing of sphenoid bone. The lesser wing of the sphenoid bone is about 3 mm thick, so the orbital superior wall easily fractures easily. If a fracture occurs of the orbital inferior wall, the orbital cavity becomes larger, the orbital contents descend. As a result, diplopia and endophthalmos arise. When the orbital medial wall gets fracture, diplopia tends to occur. Orbital lateral wall consists of orbital process of zygomatic bone and orbital surface of the greater wing of the sphenoid bone. Fracture of the orbital lateral wall usually leads to backward, downward and outward displacement of the zygomatic bone. Consequently, the orbital cavity enlarges and diplopia develops. In addition, if the fracture is near the superior orbital fissure, the oculomotor nerve may be injured, which will bring about external ophthalmoplegia and possible diplopia.[3] Data from this study show that the fracture of the orbital medial wall and inferior wall accounted for the majority (55.2% and 39.5%, respectively). Fracture of orbital lateral wall and superior wall was only, respectively (4.0% and 1.3%), which was basically same with literature reports. The cause of fracture bears relation to weakness of bone substance of orbital medial wall and inferior wall in anatomy, which have poor ability to bear external force.
2. The mechanism of orbital blowout fracture is still not clear. Generally one Hydraulic pressure transfer action is one possible mechanism. That is, when the outside force acts on the orbit, it transmits through orbital content making intraorbital pressure rise sharply. As a result, the weak place of orbital wall gets fracture. A further possibility is that of orbital wall flexion. Namely, it is believed that the external force acting on orbital margin causes the whole orbital wall to have transient deformation, resulting fracture. The authors of this study consider that orbital blowout fracture may involve both mechanisms. Because of special anatomical structure of pyramid with four sides of the orbit and particularity of the content, as external force acted on the orbit, there would be a steep rise in the intra-ocular pressure; simultaneously the orbital wall underwent a transient deformation due to the effect of external force. This leads to the fracture of thin orbital wall. It was demonstrated and proved the cases under study that fracture lines in the fracture of the orbital medial wall shifted inwards (Fig. 1). Additionally the case of the orbital wall fracture by contrecoup effect reported in the literature was not seen in this group.[5]
3. Orbital CT is examination means of first choice to diagnose orbital wall fracture. The accuracy of CT is much higher than that of X-ray. In this group 19 cases had X-ray examination after the injury, and only 10 of them

Table 1
Clinical manifestation of orbital blowout fracture

Clinical manifestation	Number of cases (%)
Periocular petechia and reduced visual acuity	76 (100%)
Reduced visual acuity	28 (36.8%)
Diplopia	17 (22.3%)
Abnormal eye movement	9 (11.8%)
Exophthalmos	2 (2.6%)
Depression of eyeball	5 (6.6%)
Injury of optic nerve	6 (7.9%)

Table 2
Vision diminution of injured eye after orbital blowout fracture

Eyesight after injury	Number of cases (%)
0.8	48 (63.2%)
0.7	12 (15.8%)
0.6	7 (9.2%)
0.5	4 (5.3%)
0.4	4 (5.3%)
0.3	1 (1.3%)

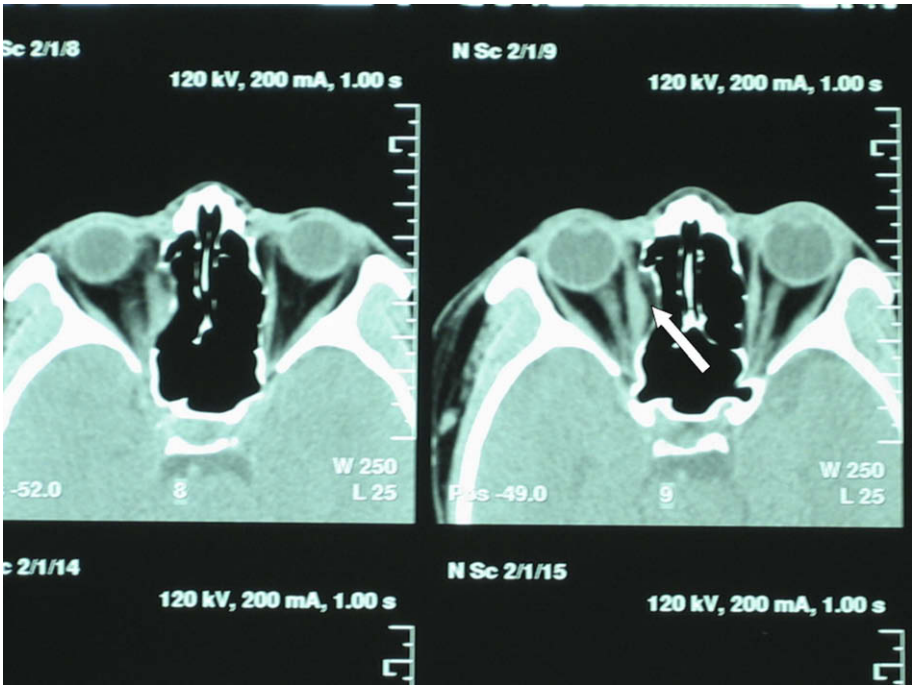

Fig. 1. CT direct sign: left eye, orbital medial wall displaced and curvature changed; indirect sign: medial rectus muscle of eyeball thickened (see white arrow).

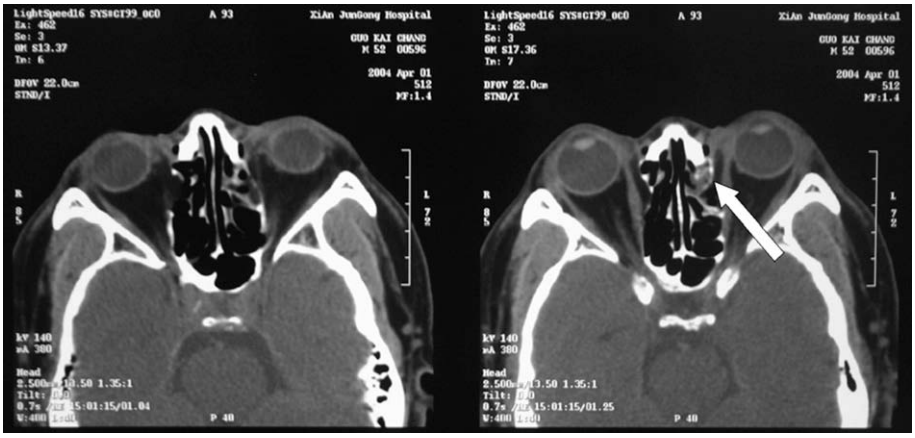

Fig. 2. CT direct sign: left eye, bone substance continuity of orbital medial wall broke off, and also orbital wall displaced; indirect sign: hematocele on the site of fracture (see white arrow).

Table 3
CT characteristics of orbital blowout fracture

Direct signs	Number of cases (%)	Indirect signs	Number of cases (%)
Interruption of bone substance continuity	44 (57.9%)	Eye muscle thickening	18 (23.7%)
Displacement of orbital wall	26 (34.2%)	Soft tissue incrassation	31 (40.8%)
Abnormal curvature of orbital wall	6 (7.9%)	Hematocele at the position of fracture	38 (50.0%)
		Intraorbital pneumatosis	24 (31.6%)

were reported to have a fracture. Subsequent orbital CT examination and confirmed that the accuracy rate of X-ray was simply 52.6% (10/19), while cranial CT examination only provided and accuracy the accuracy of diagnosis rose of 73.7% (42/57). For orbital blowout fracture, horizontal combined with coronal scanning method should be employed in the CT examination. Routine cranial CT will not always display fracture. In this group all 76 cases of orbital fracture received CT examination, but among them 57 cases had head CT

Table 4
Results of medicolegal investigation for 76 cases of orbital blowout fracture

Degree of injury	Number of cases (%)
Slight injury	69 (90.8%)
Severe injury	7 (9.2%)

examination and only 42 cases reported fracture. The other 15 cases were found having fracture when legal medical experts examined the orbits of patients who had reduced visual acuity and diplopia. So medical investigators and clinicians ought to base the judgment on a comprehensive analysis in the light of patients' history and physical examination, etc. It is suggested that the orbital CT be regarded as a conventional examining means for patients with eye trauma in the presence of diplopia or altered visual acuity. Certainly the effect will be better if spiral CT scanning is adopted to examine.[6] Orbital fracture CT characteristics include direct and indirect signs and symptoms. Direct signs comprise interruption of bone substance continuity, comminution and bone fragment displacement; indirect signs mainly refer to changes of soft tissue that fracture has caused, including changes of form and location of extra-ocular muscle and hernia of orbital content. Direct CT signs of orbital fracture in this group mainly present interruption of bone substance continuity of orbital wall (44 cases, 57.9%), displacement of orbital wall (26 cases, 34.2%), and alteration of curvature (6 cases, 7.9%). Indirect signs principally present haematoma at the site of fracture (38 cases, 50.0%), soft tissue swelling or thickening (31 cases, 40.8%), eye muscle thickening and swelling (18 cases, 23.7%), etc. The above changes are clearer under the horizontal plus coronal scanning, which can, therefore, be taken as a primary means of observing the structure of orbital wall bone substance and diagnosis of pathological process.

4. Orbital fractures can cause injury and altered function of extra-ocular muscles, which can cause to diplopia. In this group of 76 patients with orbital fracture, a total of 17 cases developed diplopia. The thickening of extra-ocular muscle presented in CT could be the main cause of diplopia after the injury. Meanwhile, orbital wall fracture and collapse resulted in the eyeball moving backwards and intraorbital pressure rose, which can also cause diplopia[7] (see Fig. 2).
5. According to article 9, item 2 of Human Slight Injury Identification Standard (PR China), simple orbital blowout fracture belongs to the scope of slight injury. It was found in statistical data of this group that patients with orbital blowout fracture did not have obvious vision diminution. Through analysis it was thought that after external force had acted on the eyeball, the external force was attenuated by the buffering of orbital wall fracture. As a result, the eye avoided external force and was not damaged. For instance, some patients even did not have changes of eyesight except for swelling of the eye, so it led to missed diagnosis of orbital wall fracture. In the meantime because orbital medial wall fracture was usually concealed, the rate of missed diagnosis increased. A medicolegal physician must be aware of the risks of missing the diagnosis.

In the appraisal outcome of this group there were seven cases of severe injury: the optic nerve had atrophy after the injury and visual function was markedly affected (4 cases); the globe collapsed and cosmetic appearance was affected (2 cases); and one patient had irreversible diplopia after the trauma.

Due to complexity of the orbital osseous structure and the soft tissue contents of the orbit and limitations of X-ray and CT imaging, the medicolegal expert must be familiar with normal anatomical structure when assessing such injuries in order not to miss an occult orbita fracture and should have a low threshold for utilising orbital CT for diagnosis.[8]

Conflict of interest statement

None declared.

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